Section 957

RESISTANCE OF COMPACTED BITUMINOUS MIXTURE TO MOISTURE INDUCED DAMAGE

LOTTMAN TEST

Utah Department of Transportation Method, supplement to AASHTO T 283 (modified UDOT procedure).

957.01 Scope

Scope of this procedure is as stated in the modified version of AASHTO T 283. In addition, Superpave Volumetric Mix Design (AASHTO PP28) requires to perform moisture susceptibility tests according to T 283 (modified version). This procedure describes the use of Superpave Gyratory Compactor (SGC) for preparation of Hot Mix Asphalt (HMA) specimens according to AASHTO T 312 and other differences from the modified version of AASHTO T 283.

957.02 Apparatus

1. Equipment for preparing and compacting from AASHTO TP4 using approved SGC.
2. Vacuum chamber capable of holding 6 inch specimens submerged in water.
3. Vacuum pump and manometer.
4. Distilled or deionized water.
5. Heavy duty leak proof plastic bags, plastic film (Saran Wrap or equivalent) and tape.
6. Freezer capable of -18 ± 5 F
7. Water bath capable of 140 ± 2 F.
8. Water bath capable of 77 ± 2 F.
9. Apparatus capable of performing indirect tensile strength test, with a load speed of 2 inches per minute.
10. Loading strip shall be 3/4 inch wide for 6 inch specimen.
11. Forced air draft ovens.
12. 0.33 ounce graduated cylinder.

957.03 Determination of Sample Size.

1. AASHTO PP28 requires to perform moisture susceptibility tests according to T283 (modified version). Compact specimens to height of 3-3/4 inches for 6 inch diameter specimen. Determine the maximum specific gravity (Rice), G_{mm}, for the given mix (AASHTO T209).

2. Determine the weight of mixture required to achieve 7% air voids at design asphalt binder content using weight-volume relationships:

   Wt. of mix = $\alpha * G_{mm} * 1679$, where α is typically near 0.91. (Uncorrected density requires weight of mix to be equal to $0.93 * G_{mm} * 1679$. The typical factor is near 0.91 for corrected (measured) density).

3. Prepare a few trial specimens using SGC to obtain desired void content of 7 ± 1 percent. Adjust the weight of the mix by making correction to the typical factor (such as 0.91) to get to within the air void limits.

4. Prepare the specimens by means of the SGC as described in the AASHTO T312. The SGC then needs to be converted to height mode. The number of gyrations will be determined by the height of the specimen 3.75 inches for the given weight of mix. Use the factor established for the given mix to compact a minimum of six specimens.

957.04 Aging and Molding the HMA

1. Aggregate preparation and batching is performed the same as for the SGC. The short term aging procedure applies to laboratory prepared loose mix only according to PP2-99. The short term aging is performed at compaction temperature for 2 hr ± 5 minutes. The short term aging is not required for the field samples from behind the paver.

2. Cure the samples in oven at 140 F for 16 hours.

3. Prepare the specimens by means of the SGC as described in the AASHTO T312. Maintain the ram pressure of 87 ± 2.6 psi on the specimen. Do not change the ram pressure and mold angle. Allow the compaction, the number of gyrations, to proceed until the desired height (3.75 inches) is reached. Let the gyratory mechanism shut off.

4. Allow specimens to cool 5-10 minutes prior to ejecting from the mold. The specimens shall be allowed to cool for a minimum of 4 hours prior to performing bulk specific gravity test.

5. Determine the bulk specific gravity of each of the compacted specimens in accordance with T166.

957.05 Preparation of Test Specimens

1. Make at least six specimens for each test. Each set of mix condition designed with lime, slurry or marinated, is divided into two subsets. One subset is tested dry condition for indirect tensile strength. The other is wet condition (freeze and warm-water soaking cycle) for indirect tensile strength.

2. This procedure does not require the storage for 72 to 96 hours at room temperature, after extraction from the molds as stipulated in T 283 (modified version).

957.06 Evaluation of Test Specimens and Grouping

1. Determine theoretical maximum specific gravity of mixture by T 209.

2. Determine specimen thickness by ASTM D 3549.

3. Determine the bulk specific gravity by T166. Express volume of specimens in cubic inches.

4. Calculate air voids by T 269.

5. Sort specimens into two subsets of at least three specimens each so that average air voids of the two subsets are approximately equal.

957.07 Preconditioning of Test Specimens

1. Test one subset (three specimens) dry and precondition the other before testing.

2. Store the dry subset at room temperature until testing. Place the specimens in a heavy duty leakproof plastic bag. Then place the specimens in a 77 F water bath for a minimum of 2 hours before testing.

3. Condition the other subset as follows:

3.1 Place the specimen in the vacuum container supported by the container bottom by a spacer. Fill the container with the distilled water at room temperature so that the specimens have at least one inch of water above their surface. Apply a vacuum of 2 -9.7 psi absolute pressure (10-26 in. Hg partial pressure) for a short time (5 to 10 minutes). Remove the vacuum and leave the specimen submerged in water for a short time (5 to 10 minutes).

3.2 Determine bulk specific gravity by T166. Compare saturated surface-dry weight with saturated surface-dry weight determined in 957.06.3 above. Calculate the volume of absorbed water.

3.3 Determine degree of saturation by comparing volume of absorbed water with volume of air voids from section 957.06.4 above. If the volume of water is between 70 percent and

80 percent of the volume of air proceed with 957.07.3.4. If volume of water is less than 70 percent, repeat the procedure beginning with 957.07.3.1 using more vacuum and/or time. If volume of water is more than 80 percent, the specimen has been damaged and must be discarded.

3.4 Cover the vacuum saturated specimens tightly with a plastic film (Saran Wrap or equivalent). Place each wrapped specimen in a plastic bag containing 0.33 ounce of water and seal the bag.

3.5 Place the plastic bags containing the specimens in a freezer at a temperature of -18 ± 5.0 F for a minimum of 16 hours. After removal from the freezer, place the specimens in a bath containing distilled water at 140 ± 2 F for 24 ± 1 hours. Cool the specimens to room temperature.

3.6 Repeat the process of freezing and thawing as described in 957.07.3.5 for five cycles. On the fifth cycle of thawing, remove the plastic bag and film from each specimen as soon as possible after placement in the bath.

3.7 After 24 ± 1 hours in 140 F water bath, remove the specimens and place them in a water bath already at 77 ± 0.9 F for 2 ± 1 hours. Add ice to the water bath to prevent the water temperature from rising above 77 F. Maintain the temperature of 77 F within 15 minutes. Test the specimens as described in next section.

957.08 Testing

1. Determine the indirect tensile strength of dry and conditioned specimens at 77 F.

2. Use the steel loading strips. Remove the specimen from 77 F water bath and place the loading strips. Place the specimen mounted loading strips between the two bearing plates in the testing machine. Apply the load to the specimen by means of the constant rate of movement of the testing machine head of 2 inches per minute.

3. Record the maximum compressive strength noted on the testing machine and continue loading until a vertical crack appears. Remove the specimen from the machine and pull apart at the crack. Inspect the interior surface for stripping and record the observation.

957.09 Calculation

1. Calculate the tensile strength as follows:

$$St \quad \frac{291{,}358\ P}{(\pi\ t\ D)}$$

where:

S_t = Tensile strength, lbf/in^2
P = Maximum load, lbf

t = Specimen thickness, inches
D = Specimen diameter, inches

2. Express the numerical index or resistant of asphalt mixtures to the detrimental effect of water as the ratio of the original strength that is retained after the freeze-warm water conditioning. Calculate as follows:

$$Tensile\ Strength\ Ratio\ (TSR) \quad \frac{S2}{S1}$$

where:
S_1 = average tensile strength of dry subset, and
S_2 = average tensile strength of conditioned subset.